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A Partition Based Novel Approach in AFIS for Forensics&Security

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Abstract

Many automatic fingerprint identification approaches have been suggested. Amongst those various methods, the minutiae-based fingerprint demonstration and recognition is widely used. Minutiae based representation has some disadvantages in comparison to other fingerprint approached in terms of sample size. This paper describes a novel concept of partition based approach for fingerprint identification which aims to improve error rates as well as processing time in matching fingerprints. We aim to split the identity image into well separated partitions in order to simplify the identification task. Our system will use the gray-scale information of the fingerprints. The system will select the primary fingerprint, perform feature extraction & feature matching to identify the image in the database by comparing the featured values of both the fingerprints. Our implementation mainly incorporates image pre-processing, image partitioning, image binarization, feature extraction and feature matching. It finally generates a score which tells whether two fingerprints match or not.

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Keywords:

Fingerprint Identification; Fingerprint Image; Image partitioning; Image Binarization; Feature extraction; Feature Values; Feature matching etc.

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1. Introduction

The use of biometrics is a growing factor in today's people. Biometrics is an identification procedure that uses the unique behavioral and physiological individualities of the human body as identifiers. Fingerprint identification systems are one of the most widely used biometric systems. Fingerprint identification is the procedure used to decide that both sets of fingerprints image are of the same finger. Fingerprint identification is a complex pattern recognition problem. It is complicated to design accurate algorithms for extracting features and matching them. There is a misconception that automatic fingerprint identification is a fully solved problem since it was one of the first applications of machine pattern recognition¹. There are number of techniques that perform fingerprint matching. Some methods encompass matching minutiae features between the two images, while others look for likenesses in the bigger structure of the fingerprint.

2. Proposed Technique

The partition-based fingerprint Identification approach is capable of dealing with low-quality images from which no feature can be extracted reliably. In this work, we have focused on partition based approach which comprises search for the correspondence between two sets of featured values. Our proposed framework is shown in figure 1. In order to simplify matching, the fresh fingerprint is pre-processed by image enhancement and image thinning, then generated enhanced grey image is split in 5 rows as well as 5 columns, after binarization of partitioned image we get digital image which goes through a feature extraction phase to generate a featured value. Then the resulting value is passed to the feature matching phase, which compares the input value against all stored values from the system database.

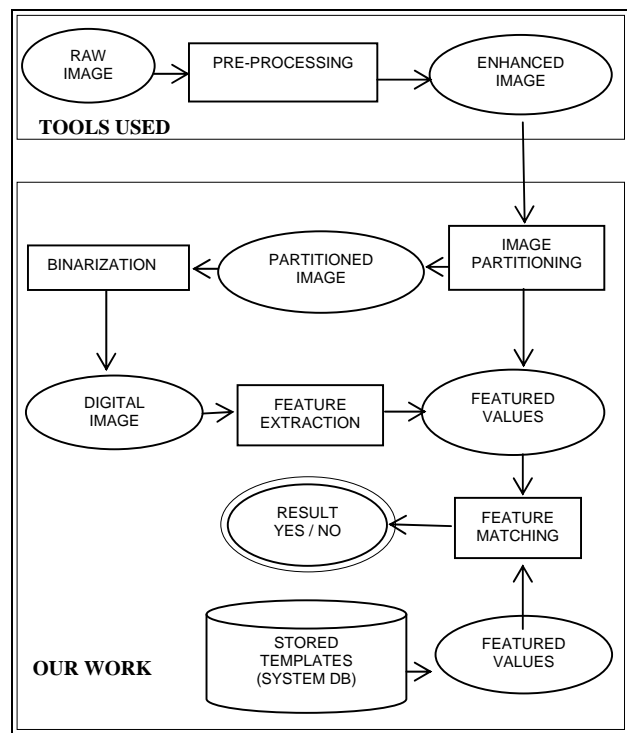


Fig.1. Proposed Framework

2.1 Pre-Processing

Automated fingerprint identification systems use digital images of fingerprints acquired from a scanner as well as from a fingerprint sensor. A large number of techniques are used to acquire fingerprints. Among them, the paper impression method remains the most popular one. In our project we will use the database available for free at Fingerprint Verification Competition (FVC's). Quality of a fingerprint is very important; it affects the feature extraction so for that first the raw image gets enhanced through image enhancement tool and second the enhanced image fed to the image thinning tool to produce a thinned image with containing only useful information (figure 2). Now this thinned image could be used for extracting features by our partition based approach; if we use the pre-processed image then result would be more accurate but pre-processing time would be an overhead.[2]

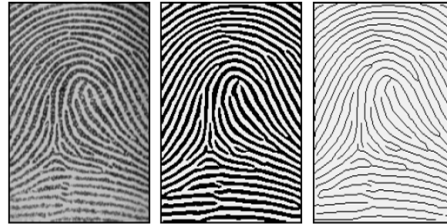


Fig.2. a) A fingerprint gray-scale image; b) Image obtained after enhancement; c) Image obtained after thinning;

2.2 Image partitioning

Partitioning means divide into parts. Partitioning is a technique by which any image gets break into the desired manner for extracting information. Image partitioning is an important processing step for our algorithm used for performing low-level feature extraction task. In any recognition the type of objects that might appear in an image can be divided into hierarchy of levels of information or features that the system needs to extract from an image. The relationship between these features makes up the object. Hence methods to extract features become important.[3]We propose an image partitioning framework to produce a region-based image representation. The proposed method partitions the image into number of rows, columns and cells separately. Those all portions then go through the binarization step. We believe that the image partitioning paradigm is widely applicable to improving performance in high-level image understanding tasks. The different regions, which are considered, are shown below (Figure 3):

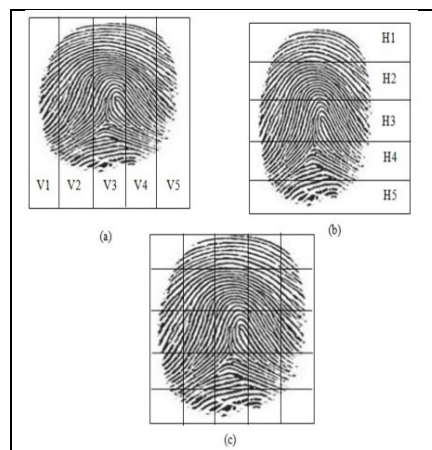


Fig.3. Partitioning Technique for a Fingerprint Image; (a) Column-wise Splitting (b) Row-wise Splitting (c) Cell-wise Splitting

2.3 Binarization

The process by which gray scale image is converted into binary image is called as binarization as shown in figure 4. The raw image that is stored in the database is allowed to get binarized i.e., it is converted into sequences of 0s & 1s. Pixel value assigned for the black is 1 and for white is 0.[4]



Fig.4. Concept of Binarization

2.4 Feature Extraction

Feature extraction refers to the process of finding a mapping that reduces the dimensionality of the patterns. Generally features can be broadly of two types – global & local features. The global features are features that depend on the function of whole object. Examples of global features are boundary length of the object, area of the object, moments, etc. Local features are depending only on a subset of the object. Corners, holes, lines, texture & curves are often used as local features. The ultimate aim in a large number of images processing applications is to extract important features from the image data⁵

In this context of feature extraction, we have the image into a number of fixed sized regions, each region having ON (1) and OFF (0) cells. In each region, number of ON cells is counted. By dividing this number by the total number of pixels in that region, we get the feature value of that region. To cover the entire image pattern, we are dividing entire Image into 19 regions as verticals, horizontals, central & corners. These feature values are stored for all the images. After feature extraction, the main task is to compare the feature values. The different regions, which are considered, are shown in figure 5;

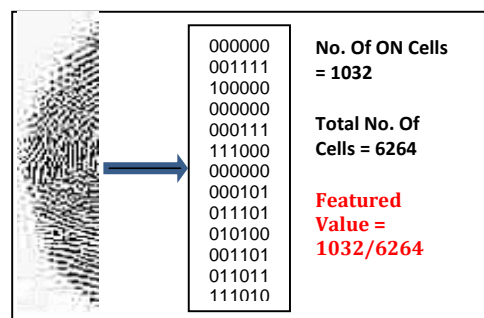


Fig.5. Feature Extraction Task

2.5 Feature Matching

In this feature matching process we use threshold to match the claimed image from the database. If the matching score is greater than or equal to the threshold value then the claimed image is reported matched otherwise unmatched.

3. Experimental Results

We have used FVC 2004 database for acquiring samples and to work on those samples. There are four packages

called DB1, DB2, DB3& DB4. The Table 1 shows the average execution time of all four databases DB1, DB2, DB3, and DB4. The Table 2 shows the accuracy of system in figures. Hence correctness of this software is 96%.

Table 1: Average Execution Time

FVC 2004 Database	DB1	DB2	DB3	DB4
Image Processing Time (Sec.)	0.163	0.198	0.154	0.169
Feature Matching Time (Sec.)	0.022	0.026	0.021	0.028

Table 2: Average Accuracy Results

Database	FVC 2004
Accurate Matching Percentage	96%
Inaccurate Matching Percentage	4%

There are two types of errors in any biometric application; FAR and FRR. FAR is the abbreviation for false acceptance rate. FAR increases when an unauthorized person is falsely accepted by the system as one of the authorize person and FRR is the abbreviation for the false rejection rate. FRR is also increases when any authorized person is falsely rejected by the system due to an unmatched. But both the FAR and FRR are also inversely proportional to each other; means when FAR increases the FRR decreases and vice-versa.[6]

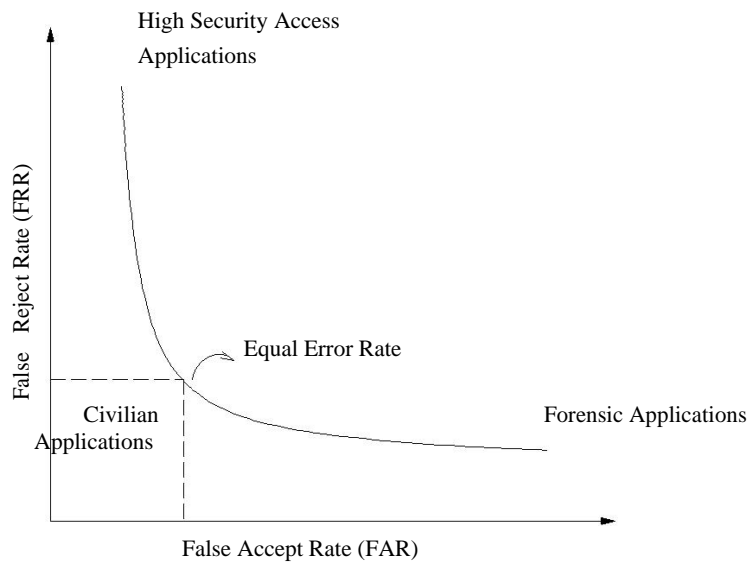


Fig.6. FAR & FRR curve

4. Conclusions

The above approach was really an effort to understand how the Fingerprint Recognition is being used in many applications like biometric measurements, solving crime investigation and also in security systems. The main objective of our proposed approach is to reduce error rates as well as processing time. A partition based matcher can also be used to implement some partial fingerprint image identification systems.

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